Revision Notes for CBSE Class 10 Science Notes for Chapter 3 Metals And Non-metals:

Physical Properties of Metals

(i) They are lustrous, i.e., they have a shiny surface.

(ii) All metals are solids except mercury which is liquid at room temperature.

(iii) Metals are ductile which means they can be drawn into wires.

(iv) Metals are malleable which means they can be beaten into sheets. The only exception is mercury.

(v) They are good conductors of heat and electricity except lead and mercury.

(vi) They have high density and high melting point except alkali metals like lithium, sodium, potassium are so soft that they can be cut with a knife.

Physical Properties of Non-metals

(i) They are non-lustrous and have dull appearance except graphite and iodine that are lustrous.

(ii) They are generally soft, except diamond.

(iii) They are non-ductile.

(iv) They are non-malleable.

(v) They are poor conductors of heat and electricity except graphite which is a good conductor of electricity

(vi) They have low density and low melting point except diamond which has high melting point.

Chemical properties of metals:

(i) Metals react with air or oxygen to form metal oxide.

Example:

$2Cu + O_2 \rightarrow 2CuO$

$4Al + 3O_2 \rightarrow 2Al_2O_3$

Metals such as potassium and sodium react so vigorously that they catch fire if kept in the open. Hence, to protect them and to prevent accidental fires, they are kept immersed in kerosene oil.

Amphoteric oxides: Some metal such as aluminium oxide, zinc oxide can react with both acids and bases to produce salt and water. Such oxides are known as amphoteric oxides.

$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + H_2O$

$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

(ii) Most metal oxides are insoluble in water but some of these dissolve in water to form alkalis (metal hydroxides).

Example:

$2Na + 2H_2O \rightarrow 2NaOH + 1H_2$

$2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2$

⇨ Metals like potassium and sodium react violently with cold water. The reaction is so violent and exothermic that the evolved hydrogen immediately catches fire.

$2K + 2H_2O \rightarrow 2KOH + H_2(g) + \text{heat energy}$

$2Na + 2H_2O \rightarrow 2NaOH + H_2(g) + \text{heat energy}$

⇨ The reaction of calcium with water is less violent. Calcium starts floating because the bubbles of hydrogen gas formed stick to the surface of the metal.

$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2(g)$

⇨ Magnesium does not react with cold water. It reacts with hot water to form magnesium hydroxide and hydrogen. It also starts floating due to the bubbles of hydrogen gas sticking to its surface.

⇨ Metals like aluminium, iron and zinc do not react either with cold or hot water. But they react with steam to form the metal oxide and hydrogen.

$2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2(g)$

$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2(g)$

(iii) Metals react with dilute acids to form salt and hydrogen.

Example:

$Mg + 2HCl \rightarrow MgCl_2 + H_2$

Reaction of metals with solutions of other metal salts

Reactive metals can displace less reactive metals from their compounds in solution or molten form.

$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$

$Cu + 2AgNO_3 \rightarrow Cu(NO_3) + 2Ag$

Special cases*

⇨Metals such as potassium and sodium react so vigorously that they catch fire if kept in the open. Hence, to protect them and to prevent accidental fires, they are kept immersed in kerosene oil.

⇨At ordinary temperature, the surfaces of metals such as magnesium, aluminium, zinc, lead, etc., are covered with a thin layer of oxide. The protective oxide layer prevents the metal from further oxidation.

⇨Iron does not burn on heating but iron filings burn vigorously when sprinkled in the flame of the burner.

⇨Copper does not burn, but the hot metal is coated with a black coloured layer of copper(II) oxide.

⇨Silver and gold do not react with oxygen even at high temperatures.

Chemical Properties of Non-metals

(i) Non-metals reacts with oxygen to form non-metal oxide.

$S + O_2 \rightarrow SO_2$

$C + O_2 \rightarrow CO_2$

(ii) Non-metals do not react with water and acids.

Reactivity series

The reactivity series is a list of metals arranged in the order of their decreasing activities.

K	Potassium	Most reactive
Na	Sodium	
Ca	Calcium	
Mg	Magnesium	
Al	Aluminium	
Zn	Zinc	Reactivity decreases
Fe	Iron	
Pb	Lead	
[H]	[Hydrogen]	
Cu	Copper	
Hg	Mercury	
Ag	Silver	
Au	Gold	Least reactive

Formation of ionic compounds:

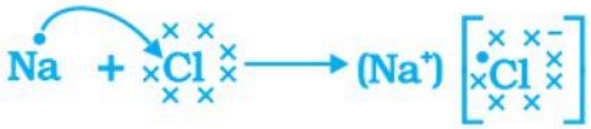
Compounds formed due to the transfer of electrons from a metal to a non-metal are known as Ionic Compounds. Here, metals get positive charge on losing electrons and non-metals get negative charge on gaining electrons. The bond formed between such positive and negative ions is called Ionic Bond.

Example:

Sodium and chlorine react with each other to form sodium chloride.

$$\underset{2,8,1}{Na} \rightarrow \underset{\substack{2,8 \\ \text{(Sodium cation)}}}{Na^+} + e^-$$

$$\underset{2,8,7}{Cl} + e^- \rightarrow \underset{\substack{2,8,8 \\ \text{(Chloride anion)}}}{Cl^-}$$



Properties of ionic compounds:

(i) Ionic compounds are solids and are hard because of the strong force of attraction between the positive and negative ions.

(ii) These compounds are generally brittle.

(iii) Ionic compounds have high melting and boiling points. (because a large amount of energy is required to break the strong ionic bonds).

(iv) They are generally soluble in water and insoluble in solvents such as kerosene, petrol, etc.

(v) They conduct electricity in molten and solution state. (They do not conduct electricity in solid state because movement of ions in the solid is not possible due to their rigid structure)

Topics deleted from the chapter are:

⇨ Basic metallurgical processes

⇨ Corrosion and its prevention.

Occurrence of Metals

Metals are generally found in the earth's crust.

⇨ The elements or compounds which occur naturally in the earth's crust are called **minerals.**

⇨ The minerals from which a metal can be profitably extracted are called **Ores.**

Extraction of Metals

Metals are categorised into three parts:

(i) Metals of high reactivity

(ii) Metals of medium reactivity

(iii) Metals of low reactivity

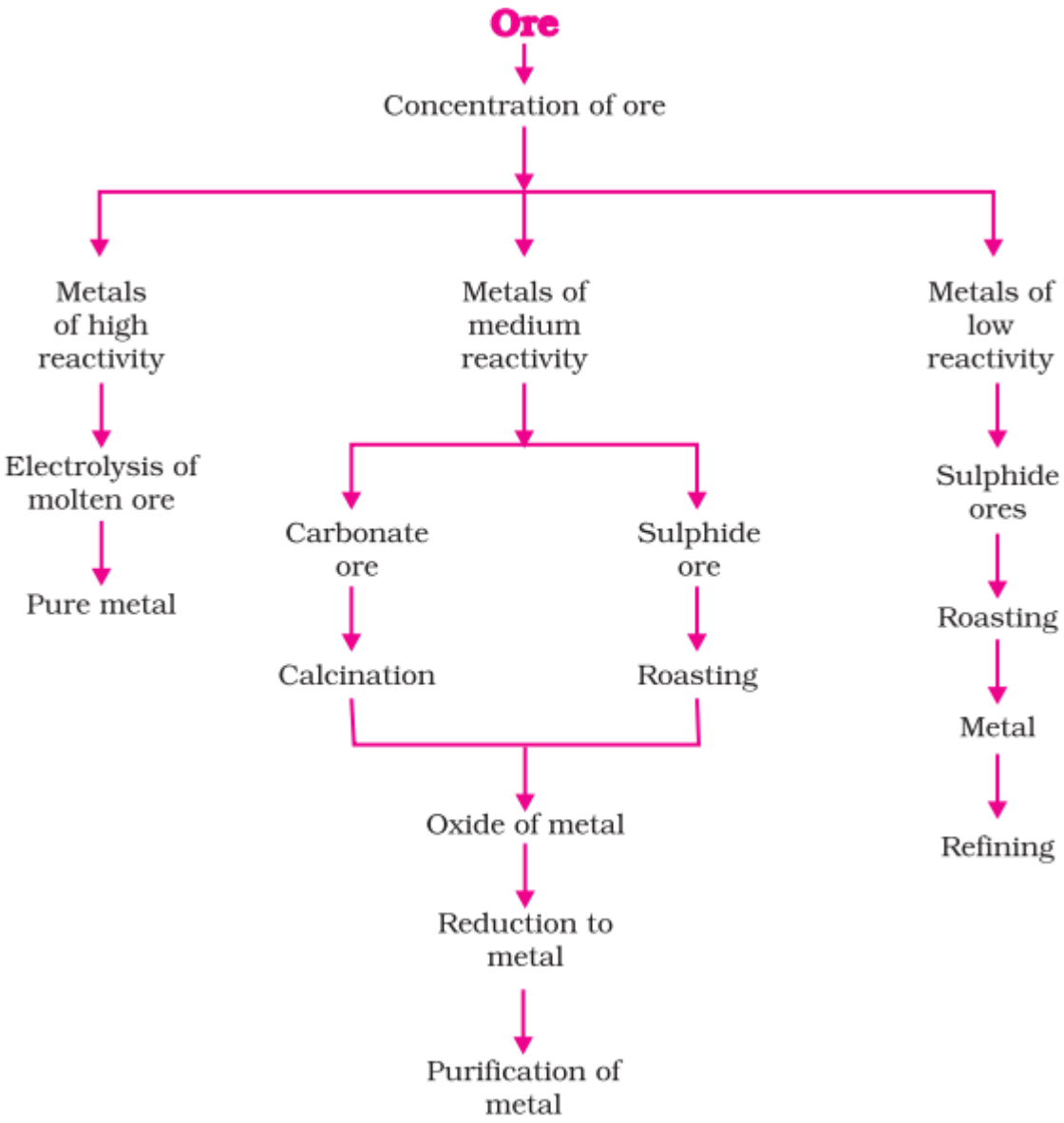
The extraction of a metal from its ore involves three major steps:

Step 1 - Concentration or enrichment of ore

Step 2 - Extraction of metal

Step 3 - Purification of metal

A summary of steps involved in the extraction of pure metal from ores is explained in the following diagram:



1. Enrichment of ores: In involves removal of impurities, such as soil, sand, etc. from mined ores.

* The impurities such as soil, sand, etc., are called gangue.

The processes used for removing the gangue from the ore are based on the differences between their respective physical or chemical properties.

Some of the process applied for concentration of ores include gravity separation, electromagnetic separation, froth flotation process, etc.

2. Extraction of metals from their ores

(i) Extraction of metals low in the activity series: Metals low in the activity series are very unreactive. The oxides of these metals can be reduced to metals by heating alone.

For example: Cinnabar (HgS) which is an ore of mercury is first converted into mercuric oxide (HgO) on heating in air. Mercuric oxide is then reduced to mercury on further heating.

$2HgS(s) + 3O_2(g)$ (Heat) $\rightarrow 2HgO(s) + 2SO_2(g)$

$2HgO(s)$ (Heat) $\rightarrow 2Hg(l) + O_2(g)$

(ii) Extraction of metals in the middle of the activity series:

The metals in the middle of the activity series such as iron, zinc, lead, copper, are usually present as sulphides or carbonates in nature.

It is easier to obtain a metal from its oxide, as compared to its sulphides and carbonates. Therefore the metal sulphides and carbonates are converted into metal oxides.

Extraction of metals from the concentrated ores

(b) Roasting: Heating of sulphide ores in the presence of excess air to convert them into oxides is known as roasting.
$2ZnS + 3O_2$ (Heat) $\rightarrow 2ZnO + 2SO_2$
(c) Calcination: Heating of carbonate ores in the limited supply of air to convert them into oxides is known as calcination.
$ZnCO_3$ (Heat) $\rightarrow ZnO + CO_2$
(d) Reduction: Reducing the metal oxides to the corresponding metals by using suitable reducing agents is known as reduction.

$ZnO + C \rightarrow Zn + CO$

⇨ The highly reactive metals such as sodium, calcium, aluminium, etc., are also used as reducing agents because they can displace metals of lower reactivity from their compounds.

⇨ These displacement reactions are highly exothermic. The amount of heat evolved is so large that the metals are produced in the molten state.

Thermit reaction: This is the reaction of iron(III) oxide (Fe_2O_3) with aluminium which is used to join railway tracks or cracked machine parts.

$Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(l) + Al_2O_3(s) + Heat$

Occurance of Metals

Minerals : Elements of compounds occuring naturally are minerals.

Ores : Mineral from which metal can be profitably extracted is an ore. For example, sulphide ore, oxide ore, carbonate ore.

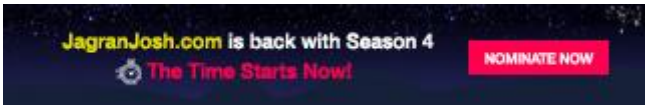
⇨ Metals at the bottom of activity series like gold, platinum, silver, copper generally occur in free state. But copper and silver also occur in sulphide and oxide ores.

⇨ Metals of medium reactivity (Zn, Fe, Pb etc.) occur mainly as oxides, sulphides or carbonates.

⇨ Metals of high reactivity (K, Na, Ca, Mg and Al) are very reactive and thus found in combined state.

Gangue : Ores are naturally found mixed impurities like soil, sand, etc. Called gangue. The gangue is removed from the ore.

Metallurgy : step-wise process of obtaining metal from its ore.



- Enrichment of ore
- Obtaining metal from enriched ore.
- Refining of impure metal to obtain pure metal.

Extracting Metals Low in the Activity Series :

By heating the ores in air at high temperature.

Mercury from cinnabar

$2HgS + 3O_2 \xrightarrow{Heat} 2HgO + 2SO_2$

$2HgO \xrightarrow{Heat} 2Hg + O_2$

Copper from copper sulphide

$Cu_2S + 3O_2 \xrightarrow{Heat} 2Cu_2O + 2SO_2$

$2Cu_2O + Cu_2S \xrightarrow{Heat} 6Cu + SO_2$

Extracting Metals in the Middle of Activity Series:

Metals are easier to obtain from oxide ores, thus, sulphide and carbonate ores are converted into oxides.

Metal ore heated strongly in excess of air (Roasting)

$2ZnS + 3O_2 \xrightarrow{Heat} 2ZnO + 2SO_2$

Metal ore heated strongly in limited or no supply of air (Calcination)

$ZnCO_3 \xrightarrow{Heat} ZnO + CO_2$

Reduction of Metal Oxide:

1. Using Coke: Coke as a reducing agent.

$ZnO + C \xrightarrow{Heat} Zn + CO$

2. Using Displacement Reaction: highly reactive metal like Na, Ca and Al are used to displace metals of lower reactivity from their compounds.

$MnO_2 + 4Al \xrightarrow{Heat} 3Mn + 2Al_2O_3 + heat$

$Fe2O_3 + 2Al \xrightarrow{Heat} 2Fe + Al_2O_3 + heat$

In the above reaction molten iron is formed and is used to join railway tracks.

This is called thermit reaction.

Extracting Metals at the Top of Activity Series :

These metals

- have more affinity for oxygen than carbon.
- are obtained by electrolytic reduction. Sodium is obtained by electrolysis of its molten chloride.

$NaCl \rightarrow Na^+ + Cl^-$

As electricity is passed through the solution metal gets deposited at cathode and non-metal at anode.

At cathode :

$Na^+ + e^- \rightarrow Na$

At anode :

$2Cl^- \rightarrow Cl^2 + 2e^-$

Refining of Metals: Impurities present in the obtained metal can be removed by electrolytic refining.

Copper is obtained using this method. Following are present inside the electrolytic tank.

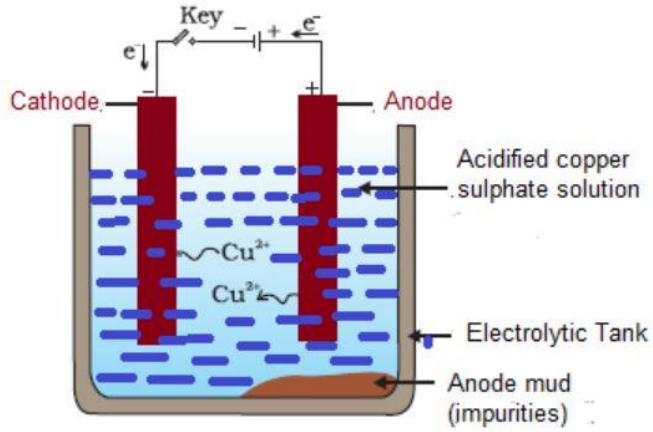
Anode – slab of impure copper

Cathode – slab of pure copper

Solution – aqueous solution of copper sulphate with some dilute sulphuric acid

⇨ From anode copper ions are released in the solution and equivalent amount of copper from solution is deposited at cathode.

⇨ Impurities containing silver and gold gets deposited at the bottom of anode as anode mud.



Corrosion: The process in which metals get corroded by action of moisture and acids present in water.

For example:

- Silver reacts with sulphur (present in air)to form silver sulphide causing the metal to appear black.
- Copper reacts with moist carbon dioxide (present in air) to produce copper carbonate resulting in a coating of green colour on the metal surface.
- Iron reacts with air and moisture from air due to which it acquires a coating of a brown flaky substance called rust.

Prevention of corrosion:

Rusting of iron can be prevented by painting, oiling, greasing, galvanizing, chrome plating, anodising and making alloys.

Galvanization: Iron or steel is coated with a protective layer of zinc because zinc is preferably oxidized than iron.

Questions for self-assessment:

Q. Give an example of a metal which

(a) is the best conductor of heat.

(b) is a poor conductor of heat.

Q. What is thermite reaction? What is its application?

Q. A solution of copper sulphate was kept in an iron pot. After a few days, the iron pot was found to have a number of holes in it. Explain the reaction and write the chemical equation for the same.

Q. NaCl does not conduct electricity in solid state whereas it does conduct electricity in solution as well as in molten state. Why?

Q. An element forms an oxide A_2O_3 which is acidic in nature. Identify A as a metal or non-metal.

Q. Distinguish between roasting and calcination.

Q. Every ore is a mineral but not every mineral is an ore. Explain.

Q. Why highly reactive metals can't be obtained from their oxides using coke as a reducing agent?

Important Questons

Short Answer Type Questions

1. Iqbal treated a lustrous, divalent element M with sodium hydroxide. He observed the formation of bubbles in reaction mixture. He made the same observations when this element was treated with hydrochloric acid. Suggest how can he identify the produced gas. Write chemical equations for both the reactions.
2. During extraction of metals, electolytic refining is used to obtain pure metals. (a) Which material will be used as anode and cathode for refining of silver metal by this process? (b) Suggest a suitable electrolyte also. (c) In this electrolytic cell, where do we get pure silver after passing electric current?
3. Why should the metal sulphides and carbonates be converted to metal oxides in the process of extraction of metal from them?
4. Generally, when metals are treated with mineral acids, hydrogen gas is liberated but when metals (except Mn and Mg), treated with HNO_3, hydrogen is not liberated, why?
5. Compound X and aluminium are used to join railway tracks. (a) Identify the compound X (b) Name the reaction (c) Write down its reaction.
6. When a metal X is treated with cold water, it gives a basic salt Y with molecular formula XOH (Molecular mass = 40) and liberates a gas Z which easily catches fire. Identify X, Y and Z and also write the reaction involved.
7. A non-metal X exists in two different forms Y and Z. Y is the hardest natural substance, whereas Z is a good conductor of electricity. Identify X, Y and Z.
8. The following reaction takes place when aluminium powder is heated with MnO_2
   $3MnO_2(s) + 4Al(s) \rightarrow 3\ Mn\ (l) + 2\ Al_2O_3\ (l) + Heat$
   - (a) Is aluminium getting reduced?
   - (b) Is MnO_2 getting oxidised?

9. What are the constituents of solder alloy? Which property of solder makes it suitable for welding electrical wires?
10. A metal A, which is used in thermite process, when heated with oxygen gives an oxide B, which is amphoteric in nature. Identify A and B. Write down the reactions of oxide B with

HCl and NaOH.

11. A metal that exists as a liquid at room temperature is obtained by heating its sulphide in the presence of air. Identify the metal and its ore and give the reaction involved.
12. Give the formulae of the stable binary compounds that would be formed by the combination of following pairs of elements.
    - (a) Mg and N_2
    - (b) Li and O_2
    - (c) Al and Cl_2
    - (d) K and O_2

13. What happens when
    - (a) $ZnCO_3$ is heated in the absence of oxygen?
    - (b) a mixture of Cu_2O and Cu_2S is heated?

14. What happens when
    - (a) $ZnCO_3$ is heated in the absence of oxygen?
    - (b) a mixture of CuO and CuS is heated?

15. A non-metal A is an important constituent of our food and forms two oxides B and C. Oxide B is toxic whereas C causes global warming
    - (a) Identify A, B and C
    - (b) To which Group of Periodic Table does A belong?

16. Give two examples each of the metals that are good conductors and poor conductors of heat respectively.
17. Name one metal and one non-metal that exist in liquid state at room temperature. Also name two metals having melting point less than 310 K (37°C)
18. An element A reacts with water to form a compound B which is used in white washing. The compound B on heating forms an oxide C which on treatment with water gives back B. Identify A, B and C and give the reactions involved.

19. An alkali metal A gives a compound B (molecular mass = 40) on reacting with water. The compound B gives a soluble compound C on treatment with aluminium oxide. Identify A, B and C and give the reaction involved.
20. Give the reaction involved during extraction of zinc from its ore by
    - (a) roasting of zinc ore
    - (b) calcination of zinc ore

21. A metal M does not liberate hydrogen from acids but reacts with oxygen to give a black colour product. Identify M and black coloured product and also explain the reaction of M with oxygen.
22. An element forms an oxide A_2O_3 which is acidic in nature. Identify A as a metal or non-metal.
23. A solution of $CuSO_4$ was kept in an iron pot. After few days the iron pot was found to have a number of holes in it. Explain the reason in terms of reactivity. Write the equation of the reaction involved.

Long Answer Type Questions

1. A non-metal A which is the largest constituent of air, when heated with H_2 in 1:3 ratio in the presence of catalyst (Fe) gives a gas B. On heating with O_2 it gives an oxide C. If this oxide is passed into water in the presence of air it gives an acid D which acts as a strong oxidising agent.
    - (a) Identify A, B, C and D
    - (b) To which group of periodic table does this non-metal belong?

2. Give the steps involved in the extraction of metals of low and medium reactivity from their respective sulphide ores.
3. Explain the following
    - (a) Reactivity of Al decreases if it is dipped in HNO 3
    - (b) Carbon cannot reduce the oxides of Na or Mg

- (c) NaCl is not a conductor of electricity in solid state whereas it does conduct electricity in aqueous solution as well as in molten state
- (d) Iron articles are galvanised.
- (e) Metals like Na, K, Ca and Mg are never found in their free state in nature.

4. (i) Given below are the steps for extraction of copper from its ore.
   Write the reaction involved.
   - (a) Roasting of copper (1) sulphide
   - (b) Reduction of copper (1) oxide with copper (1) sulphide.
   - (c) Electrolytic refining

   Draw a neat and well labelled diagram for electrolytic refining of copper

5. Of the three metals X, Y and Z. X reacts with cold water, Y with hot water and Z with steam only. Identify X, Y and Z and also arrange them in order of increasing reactivity.
6. An element A burns with golden flame in air. It reacts with another element B, atomic number 17 to give a product C. An aqueous solution of product C on electrolysis gives a compound D and liberates hydrogen. Identify A, B, C and D. Also write down the equations for the reactions involved.
7. Two ores A and B were taken. On heating ore A gives CO_2 whereas, ore B gives SO_2. What steps will you take to convert them into metals?